Analysis of Army Spare and Repair Microcircuits for Determination of Commercial Equivalents and Parts Standardization – A Follow-On Study

Final Technical Report
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TABLE OF CONTENTS

1.0 Introduction

As the demand for microelectronics from the commercial sectors of the economy continues to increase, the Department of Defense (DoD) is faced with the increasing difficulty of sustaining its arsenal of ships, planes, helicopters, missiles and other weaponry. When combined with the requirements of the consumer market, the technological advances within the electronics arena have become so rapid that the state-of-the-art products of today are literally obsolete six months from now. The dilemma of dimensioning manufacturing sources and material shortages (DMSMS) and technological obsolescence requires a significant annual investment from the Army, Air Force, and Navy, and a growing "industry" has arisen within the Defense Community to help mitigate obsolescence problems.

In addition to the short technology life cycles within microelectronics and the increased commercial sector demands, the military also faces the predicament of trying to influence the market with very little quantifiable clout. As the costs of weapon systems have increased and the military budgets have become leaner, the military buys fewer and fewer systems. This translates into the military comprising less than one-half of one percent of the total microelectronics market. Many electronics manufacturers have decided that the cost to chase 0.3 percent of the market is simply not worth the effort. Thus the DoD is faced with an environment where most manufacturers are unwilling to adapt their product lines to meet the rigorous specifications of the military.

To address the problems of non-availability, the use of commercial-off-the-shelf (COTS) components has been advocated. The move toward COTS was precipitated by Defense Secretary William Perry's 29 June 1994 memo, "*Specifications & Standards - A New Way of Doing Business*," which in part mandated the DoD to "increase access to commercial state-of-the-art technology."

As the DoD migrated from a mil-spec environment to one more amenable to the use of COTS, it became apparent that an appropriate toolset needed to be developed to assist the government designer in the selection of COTS items. This realization led in part to the Defense Standardization Program (DSP) promoting the development of the *AMCOM Standardization Tool for Commercially Available Microcircuits* (ASTCAM). The ASTCAM standardization effort was funded in 1999 and is the forerunner of the project that is the subject of this report. ASTCAM sought to assist the engineer and logistician in searching for a candidate replacement COTS item. Prior to ASTCAM, the designer was required to search through vendor catalogs and item data sheets until a suitable replacement was identified. This process was leading to a proliferation of microelectronic parts being used to perform specific functions within DoD weapon systems. The successful implementation of the ASTCAM tool should serve to narrow the focus for replacement parts and hence assist in the DSP standardization mission.

2.0 Purpose

This standardization project was funded by the DSP and sponsored by the U.S. Army Aviation and Missile Command (AMCOM) Engineering Directorate. The purpose of this standardization project was to enhance, maintain and implement the ASTCAM and is a follow-on effort to previous work performed in 1999 under the same project title. The 1999 phase of this standardization project included an analysis of the existing U.S. Army AMCOM Industrial Base spare and repair parts database of microcircuits to determine the feasibility of inserting commercial equivalent parts. The DoD's spare part management process is plagued by part number proliferation resulting in unnecessary labor expenditures to identify a suitable repair part. The original (1999) analysis evaluated known product attributes and performance characteristics of military spare and repair parts to corresponding vendors' commercial items that were readily available. Product attributes included operating voltage, silicon manufacturing process and package outline. The outcomes of the 1999 effort were a database of military microcircuit devices currently in use at AMCOM, an associated database of possible commercial equivalents, and a software interface to aid in the search and retrieval of this information. The results of the Phase One analysis were disseminated throughout DOD via the Internet and CD-ROM to maximize commercial parts standardization within the Services.

The current project efforts were focused on the implementation of the ASTCAM into the AMCOM Tech Loop process. The Tech Loop process is used to screen AMCOM procurements to determine availability, analyze for performance-based specification conversion and determine COTS replacement potential. The ASTCAM was to be integrated into this process to ensure that mil-spec items are replaced by commercially available items where system requirements allow. The use of the ASTCAM should also ensure that COTS items used as replacement spare and repair parts are standardized, thus negating the potential for parts proliferation. In addition, the current efforts were to continue the 1999 analysis and population of microcircuit parts into the ASTCAM. Other government agencies, including DSCC, were solicited to provide addition listings of microcircuits. As an added activity, the original ASTCAM database was refreshed to ensure that microcircuit information remained current.

3.0 Original ASTCAM Development Efforts

To understand ASTCAM and benefit fully from its use, it is important to review the design assumptions used during its original development. The microelectronic-analysis team generated a set of ground rules that were used during the research and population of the database. These ground rules included:

1. *The case design for the new device is a direct plug-in replacement.* COTS items were only included that had the same basic form and fit as the original mil-spec item.

2. *An identified substitute part is currently being manufactured.* One of the primary tasks of the AMCOM microelectronics team is to analyze the availability of all piece-parts. Microelectronic parts are considered to be obsolete when they are no longer being

manufactured by an approved source. For this effort, only currently manufactured COTS items were included as potential replacements.

3. *The functionality of the substitute part is essentially the same as the original part (i.e. timing, voltage, etc.)* The analysis to find potential replacement microcircuits focused on matching the functionality of the COTS item to that of the original mil-spec item.

4. *Temperature range is different for industrial grade and commercial grade parts*. The industry accepted temperature ranges have been used during the analysis process. These temperature ranges are as follows:

   i. Mil-spec temperature range: -55ºC to 125ºC
   ii. Industrial grade temperature range: -40ºC to 85ºC
   iii. Commercial grade temperature range: 0ºC to 75ºC

5. *Any potential replacement device must be validated in the specific design application*. It is extremely important that the user of the ASTCAM system understand the tool's purpose. The goal of ASTCAM is to provide a means to quickly identify potential COTS equivalent microcircuits. Any items identified using ASTCAM must be validated for the specific design application. ASTCAM is **not** to be considered as a tool that will provide direct replacement parts. ASTCAM was developed in part by capturing the design expertise of electronics engineers who are experienced in military applications. As an expert system, ASTCAM provides the novice engineer or logistician an understanding of the basics of employing COTS electronics within a military application. However, ASTCAM does not replace the fundamental design engineering process. Only after a complete engineering evaluation (analysis, breadboard and test, subjecting the part to the specific environment in which the military system will operate, etc.) should the part be considered as an accepted replacement. Typically, the operating temperature range is the primary difference between the military part and the candidate industrial or commercial part. However, a complete analysis of the original part, the operating environment, and the parameters of the replacement part must be conducted.

4.0 Technical Approach

The approach to accomplishing the current efforts was based on a three-pronged attack. First, the AMCOM managed parts from the Phase One project were to be re-evaluated and updated in the ASTCAM database. Secondly, additional microelectronic parts from other government agencies, including DSCC, were to be evaluated and added to the ASTCAM database. Lastly, the ASTCAM tool was to be integrated into the AMCOM Tech Loop process.

4.1 Refresh of Existing Data

The first task in accomplishing the current effort was to refresh the database of AMCOM managed parts that were identified in the 1999 project. The original ASTCAM database included the U.S. Army AMCOM database of microelectronic spare and repair parts and

represented microelectronics used within a number of Army weapon systems, including ATACMS, Avenger, HAWK, Hellfire, Javelin, MLRS, PAC3, Patriot, and THAAD. In evaluating microelectronics, it is imperative that assessments of availability be conducted as an on-going effort. The technology changes within the microelectronics arena are so rapid that a tool such as ASTCAM can quickly become dated and its usefulness substantially diminished unless rigorously maintained.

4.2 Evaluation of New Parts Data

In addition to the reevaluation of the existing database of microelectronics, component piece parts from other government agencies were identified and added to the database. These parts were identified in part from a search of the Standard Microcircuit Query Tool, which is a database and search engine made available by the Defense Supply Center – Columbus (DSCC).

4.3 Integration of ASTCAM into the Engineering Process

No software product or engineering analysis tool can be considered a complete success without implementation into its "real world" arena of concern. While the original effort served as a good proof of concept, the follow-on work sought in part to identify the most appropriate usage of the ASTCAM tool. In this evaluation, the research sought to identify candidate activities within the AMCOM Engineering Directorate where the use of the tool could provide a direct benefit. In addition, the ease of integration into the current process was considered essential. The goal of this phase of the project was not only to implement ASTCAM into a process, but also to document a procedure that would be generic to other Services and/or organizations.

5.0 Results

Using the technical approach outlined in Section 4.0, the AMCOM microelectronics team was successful in implementing its technical approach to achieve the desired objectives. The original database was re-evaluated to determine the availability of potential substitute parts. Additional microelectronic spare and repair parts were identified from other government agencies, analyzed for availability and COTS technology insertion potential and added to the database. Lastly, the ASTCAM tool was integrated into the existing AMCOM Tech Loop process.

5.1 Database Refreshment and Enhancement

The original ASTCAM development identified over 5000 microelectronics components from the AMCOM spare and repair parts database that could possibly exploit COTS substitute devices. During the analysis process, if neither industrial nor commercial parts were available, the analysts identified military parts as substitutes (if available) and included those devices in the ASTCAM database. In total, the Phase One effort identified 12,139 piece parts that were possible candidates for substitution, and associated these original parts with 23,945 potential replacement parts.

This follow-on effort reevaluated the original 12,139 piece parts plus the 23,945 potential substitutes for availability. Any changes to this information was updated and included in the current ASTCAM database.

A total of 10,485 additional items were added to the database for evaluation. A large percentage of these items were identified as managed by the Defense Supply Center – Columbus (DSCC). In order to initially extract the candidates from DSCC, the Standard Microcircuit Query Tool (available at www://dscc.dla.mil) was used. The evaluation of the combined old and new database of 22,624 microcircuit piece parts yielded a potential of 55,242 possible replacement items.

The primary interface provided to ASTCAM is much the same as in the original study, and is presented in Figure 1.0.

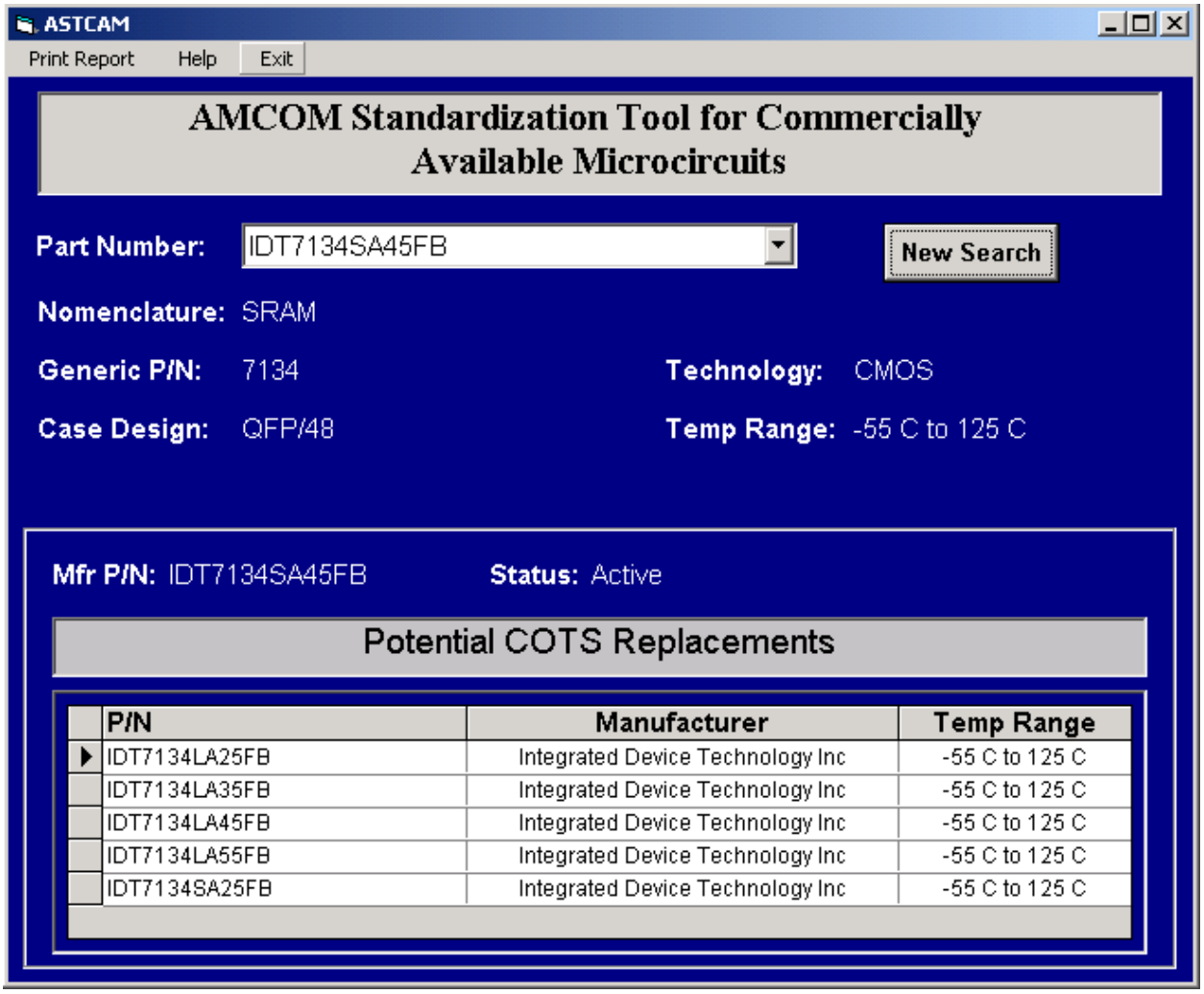

Figure 1. ASTCAM 2.0 Primary Interface Screen

The information provided on the primary interface screen includes the item part number, nomenclature, generic part number, case design, technology and operating temperature range. The bottom section of the screen provides the manufacture's part number and the potential COTS replacements. The name of the manufacturer and operating temperature range of the candidate replacement part are also provided. One major change that was implemented during the current task was the elimination of the "Current Known Manufacturers" entry for the microelectronic part under evaluation. After significant discussion and research it was determined that this information could not be presented as reliably as it should for a database of this magnitude. Under the Phase One effort, all piece parts included in the database had undergone an analysis for manufacturer availability within the past 6-24 months. Once the database was expanded, the magnitude of correctly assessing all entries anew was well beyond the scope of the task, and appeared to add minimal value to the end product.

During the analysis process, a maximum of five replacements parts were identified for satisfying each specific part number. The intent of this task was not only to provide a starting point in identifying a replacement part, but also in providing a finite number of choices. One of the problems of migrating to COTS microelectronic components is the proliferation of part numbers. This task emphasizes the importance of standardization by identifying the most promising candidate parts for the military design engineer.

5.2 Other ASTCAM Features

The user of ASTCAM 2.0 will encounter two other screens during the use of this program. The opening screen, Figure 2, is displayed immediately upon entering the program. The user will have two options from this screen: either start the program or view program information.

Figure 2. ASTCAM Opening Screen

If the user chooses to view the program information, the screen illustrated in Figure 3 will be displayed. This screen presents an overview of the ASTCAM functions, along with the ability to view this final report on-line. Selection of the "Start Program" button will return the user to the primary ASTCAM screen (Figure 1).

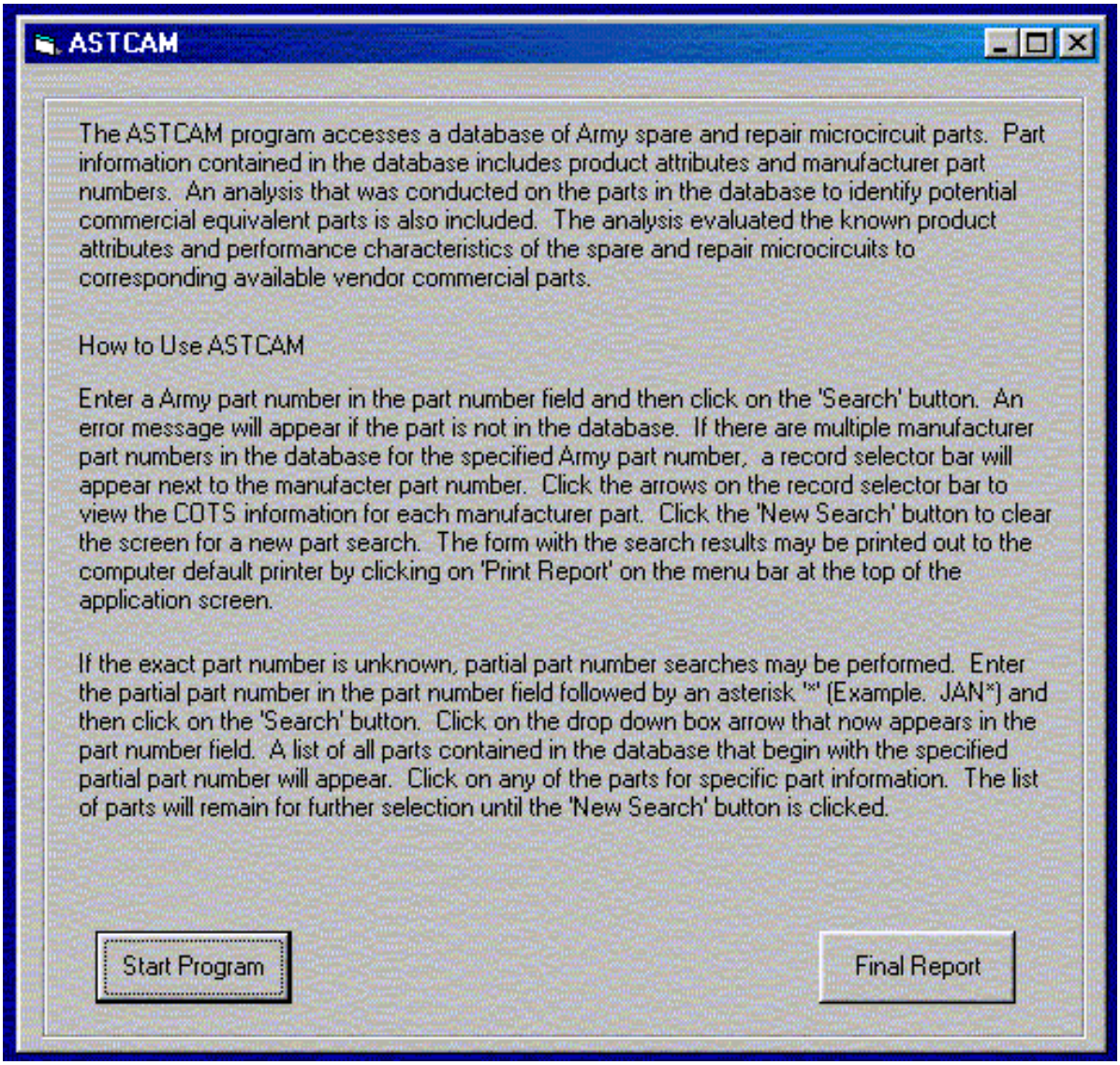

Figure 3. ASTCAM Help Screen

5.3 Integration into the Tech Loop Process

ASTCAM serves as both a database of microelectronic parts and a user interface that is not only used to search the database, but also explain the complexities of substituting COTS components for military grade parts. The logic used to develop and integrate the ASTCAM tool can provide a good orientation for the non-expert electronics engineer. It is recognized that the ASTCAM knowledge base may be of limited benefit to an expert electronics designer fluent in the use of commercial grade components. However, the intended use of ASTCAM is to address the needs of the non-expert, i.e. the logistician, procurement analyst, or team member who may not be aware of the intricacies of COTS and standardization.

The initial Phase One effort under which ASTCAM was developed served as a proof of concept. The current effort, however, sought not only to expand the database but also implement the tool into an existing process. Figure 4 represents such a process currently in use within the AMCOM Tech Loop Activity.

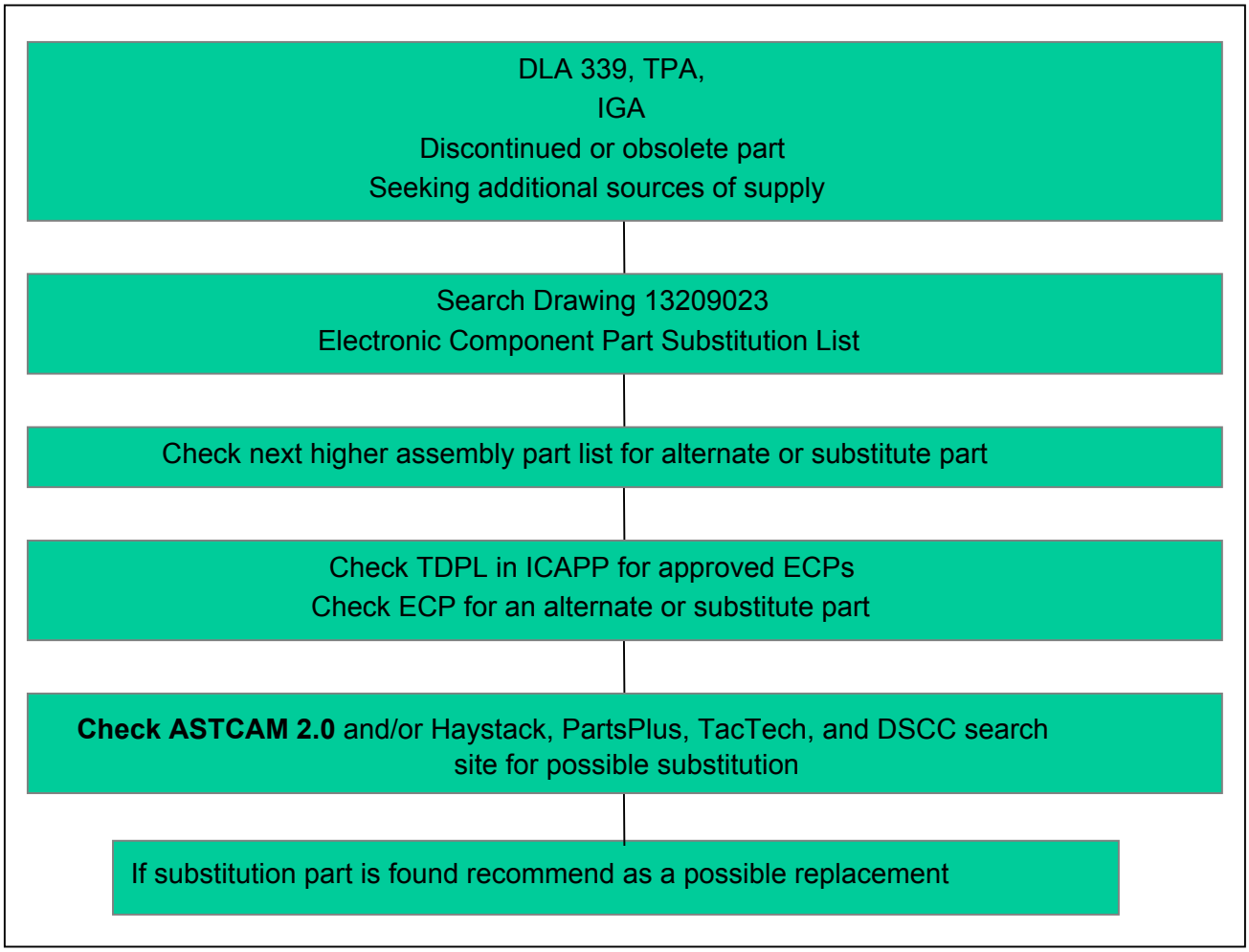

Figure 4. Example Tech Loop Search Process

The AMCOM Tech Loop encompasses a number of activities related to the technical review of potential procurement packages. One function of the Tech Loop is the search for acceptable substitutes for obsolete parts. The substitute part search action is created by one of three events: a Defense Logistics Agency (DLA) Form 339 (Request for Engineering Support), a Technical Post Award (TPA) request, or an Intercept Group Pre-Award Action (IGA). Upon initiation of one of the above three actions the Tech Loop will begin a search for either the substitute part or an additional source of supply for the discontinued or obsolete part.

The second step in the process is somewhat unique to the AMCOM environment. An Electronic Component Part Substitution List, referred to as Drawing 13209023, has been generated for AMCOM electronic parts. This listing provides the next higher assembly (NHA), reference designator, parts list part number, part number priority code, approved substitutes, and substitute part priority code. Drawing 13209023 provides a quick reference for known approved substitutes; however, since much of the Tech Loop function deals with part number searches for components without approved substitutes, this search may not yield a solution.

The logistician will then check the next higher assembly parts list for alternate or substitute parts, since they are sometimes included on this listing. If no substitute is found, the logistician will then search the technical data package listing (TDPL) in ICAPP for approved engineering change proposals (ECPs). In an ECP is found, it is checked for inclusion of an alternate or substitute part. This step in the process is necessary because an ECP may have been approved but not incorporated.

If the above steps (or similar activities) do not yield an appropriate substitute, the ASTCAM tool can then be integrated into the process, as it has at AMCOM. In the past, the AMCOM logistician was required to go to external databases (both commercial and government) to search for potential substitute parts. In the case where commercial databases were required, this drove up the expense of the search, since these databases generally require a subscription and a substantial annual fee. In addition, searches of multiple databases typically yielded inconsistent results, which in turn contributed to the proliferation of non-standard commercial parts into the DoD inventory. ASTCAM provides a narrow choice of the most appropriate candidate parts for the logistician to consider. This saves time for the analyst, avoids the cost of expensive databases, and aides in the attempt to standardize on a substitute item.

The last step in the Tech Loop process is the recommendation of a substitute part as a possible replacement. It is extremely important that the user understand that ASTCAM is **not** to be used to provide replacements directly. The engineer should perform a preliminary background assessment and report the findings and make recommendations. Afterwards, the design authority should perform a complete engineering evaluation. Only after a complete engineering evaluation should the part be considered a replacement.

6.0 Conclusions

The purpose of this task was to refresh, enhance and implement the results of the Phase One standardization study that led to the creation of ASTCAM. To that end, this project has been successful.

The latest version of ASTCAM now includes microelectronic part numbers from both AMCOM and DSCC, and includes over 22,000 part numbers and more than 55,000 potential substitute parts. The concept of ASTCAM has not only been validated on the AMCOM master database of microelectronic parts, but also expanded to include DSCC managed items, thus giving it applicability throughout the DoD.

In addition to proving the concept of ASTCAM, the implementation of this tool into an existing process should provide other organizations an understanding of how it can be used. The ASTCAM is now a component within the AMCOM Tech Loop process. It has already been discussed how this can facilitate a quicker search at less expense for the government, while also assisting in the DSP mission to standardize the spare and repair parts inventory.

7.0 Recommendations

As a result of this task it is recommended that the updated ASTCAM database and tool be made available throughout the DoD. This can be done through various means; however, delivery via the Internet still presents the most appropriate option.

The original ASTCAM is currently downloadable from the DSP website as an application. However, the conversion of the application to one that is web-based would provide an easier, more efficient means to apply the tool. It is therefore recommended that ASTCAM be converted to a web-based application. The use of the Internet with the required level of security could allow access to the database without the problems of obsolete hardcopy, i.e. CD-ROM or obsolete data files. By linking into the database, updates, enhancements and modifications can be made at the server level, thus accommodating the user community in the most efficient and cost-effective manner.

ASTCAM was developed originally as a proof of concept and has now been upgraded to prove its implementation utility. It is recommended that other organizations adopt the ASTCAM tool and add their own microelectronics information into the database. To reap the full benefits of the tool, it should continue to grow. ASTCAM should be populated with as many components from the Services as possible to become a powerful tool to not only promote standardization but also mitigate obsolescence. Regular maintenance and enhancements are encouraged.

Lastly, it is recommended that the database of parts be refreshed on a periodic (at least annual) basis. The dynamic environment of microelectronics requires constant monitoring. In order to ensure that COTS items that are recommended for replacement are not themselves obsolete, the database must be updated.

Appendix A

Definitions of ASTCAM Database Attributes

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Part Number

The Part Number is to be entered by the user. The ASTCAM application is structured such that the part numbers to be entered are either AMCOM or Defense Supply Center Columbus (DSCC) part numbers. The part numbers included in the ASTCAM application are those derived from the AMCOM and DSCC databases of microelectronic parts. After the part number is entered, a search is performed of the ASTCAM database. The ASTCAM master database lists a corresponding manufacturer part number for each part number. There may be more than one manufacturer part number in the database for one ASTCAM part number. The objective of the ASTCAM task was to find from 1 to 5 potential substitute parts for each manufacturer part number. If there are two manufacturer part numbers for one part number, then as many as 10 potential substitute parts may be provided.

Nomenclature

The Nomenclature is the common name or description of the item referenced by the Part Number entry. The Nomenclature may be general, such as Microcircuit, or specific, such as DUAL 4-BIT NON-NVRTG BUFFER/DRIVER.

Generic P/N

Generic Part Number is the industry identifier for a basic manufacturer number. This identifier in most cases serves as the key numeric portion of the Part Number, while excluding all prefixes and suffixes. As an example, the generic representation of the part number is 54ABT2244, which excludes the prefix SN- and the suffix -J. "54" signifies a military device which is a device characterized for operation over the full military temperature range of -55°C to 125°C (while "74" signifies a commercial device which is characterized for operation from 0°C to 70°C). "ABT" defines the part as being in the Advanced BiCMOS Technology family. "2244" defines the particular features of the ABT part which includes that the device is an octal buffer with an equivalent output resistance of approximately 30 ohms. The complete part number is SN54ABT2244J.

Case Design

The Case Design attribute describes the basic form and fit of the electronic component. The case design typically consists of two parts: package type and pin-out. The package type in the example is DIP, which is an acronym for dual-in-line package. One definition of DIP is as follows: "The most common type IC package; circuit leads or pins extend symmetrically outward and downward from the long sides of the rectangular package body." The pin-out, or the number of component leads, in this case is 20. Other package types are Flat, Can, and PGA.

Technology

The Technology attribute describes the particular construction of a device. For example, a technology type is BiCMOS. This type component combines elements of both bipolar and CMOS technologies onto a single chip, adding an NPN bipolar transistor output module to a core CMOS circuit structure. The result of this combination is a microcircuit that has high speed, high drive, and low power consumption.

Temperature Range

The temperature range for all mil-spec microelectronics is -55ºC to 125ºC. The industrial grade and commercial grade temperature ranges are -40ºC to 85ºC and 0ºC to 75ºC, respectively.

The lower section of the ASTCAM user interface screen contains the results of the search. It includes the Manufacturer's Part Number and Status, along with the Part Number, Manufacturer and Temperature Range for up to five potential replacement parts. The following are descriptions of these items.

Manufacturer (Mfr) P/N

Typically, an AMCOM part is an upgrade or up-screen of a manufacturer's part; upgrading or adding parameter(s) to match the AMCOM part specifications. The manufacturer's part number displayed in ASTCAM is the vendor's representation, as called out in the vendor data book, of the AMCOM part number. There may be more than one manufacturer part number (Mfr P/N) that represents an entered Part Number. If there are multiple manufacturer part numbers, a record selector bar will appear to the right of the Status field. Click on the down arrow to view the COTS information for each Mfr P/N.